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(54) **Bilateral communication system without contacts for microprocessor credit cards.**

(57) The present invention concerns a reading and recording system for microprocessor and memory chip cards using a reader, without electric contacts, and electromagnetic coupling utilizing a new type of modulation termed "bounded space" offering significant advantages for communication safety, simplicity of execution and integration, one which occupies a very narrow radiation frequency spectrum.

Card 1 includes in its volume the electrical components for communication and calculation in central zone 2 and two plane reels 3 and 4, connected to the two similar reels 6 and 7 of reader 5. The power supply, data and clock for the card are transmitted by a radio-frequency signal sent by the reader, alternately switched on the two reels 6 and 7. The card responds with a modulated frequency signal using two frequencies that are sub-units of the reader transmission frequency.

The system according to the invention is specifically designed for very short-distance communication, for credit cards, key cards and computer media.

The present invention concerns a very short-distance bilateral communication system using electromagnetic coupling between an active reader-recorder and a passive reader-recorder without its own power supply. The latter device is a microprocessor credit card – "chip card", key card for high-security systems, or "intelligent" computer medium.

It is known that modern credit, microprocessor and memory chip cards use a group of contacts to communicate that permit the reader to establish electrical connections using appropriate sensors. The signals transmitted include:

- power supply in continuous current from the card circuit,
- the clock signal for numerical data,
- the entering or exiting data signal.

The three connections comprise the minimum requirement; usually five signals are transmitted, to simplify the card circuit.

The current electromechanical reading system equipped with contacts has disadvantages:

- the precision engineering section of the reader is relatively fragile, large and costly,
- it requires permanent periodic maintenance,
- like every mechanical system, wear and tear decreases its life span,
- it is vulnerable to acts of vandalism: the introduction of inadequate objects or products in the reader slot renders it non-functional or causes definitive destruction
- the reader cannot be watertight and requires a protected location,
- the credit card itself must also be carefully protected, and the contacts must be clean, dry and intact.

The system according to the invention permits a reader-card dialogue without contacts and without moving mechanical parts, and the disadvantages cited above do not exist.

We are familiar with systems for the identification of persons who have "free hand" key cards operating without contacts and without a power supply, using radio-electric means.

These systems include a fixed interrogator post issuing permanent electromagnetic signals radiated by an antenna; if the identification card is in the interrogator area of operation , it transforms the captured signal into power supply energy for its electronic part. This part generates a coded radio-electric signal containing a unique message for each card that is received and handled by the interrogator post. Passage of the cardholder can thus be authorized and this event can then be recorded.

In general, this type of system does not permit a true dialogue, bilateral communication between the interrogator and the card; in order to change the data contained in the card memory, the contacts must be called upon, as was true in the case of the cards cited above, or an auxiliary, electromagnetic device must be used designed solely for recording. Traditional modulation must be used to transmit data to the card: amplitude modulation (AM), phase modulation (PM), or frequency modulation (FM).

The primary disadvantage of this type of system applied to microprocessor card readers is the requirement to use a broadband frequency. For a modern credit card, the dialogue is quite voluminous, due to the large quantity of data to be exchanged; to make it easy to use, the data must be transmitted at high speed, and therefore high rates must be reached. If the interrogator beams signals modulated with high data rates, the radio-frequency spectrum occupied becomes too high and current regulations for radio frequencies may limit or even prevent its use.

One of the goals of the invention is to propose a new type of modulation, one that may be termed "bounded space modulation" presenting essential benefits for this particular application.

All the other types of radio modulation cited were designed with the apparent goal of sending information at a maximum distance by modifying one of the carrier frequency parameters. Independent of the distance, the radio-electric signal keeps its modulation and the frequency band occupied at the same width; the only parameter that changes is the average amplitude of this signal.

To transmit information to a credit card, it is desirable for safety reasons that the range of action not exceed a dozen centimeters. The modulation according to the invention was designed, among others, for a specific purpose: communication is not achievable for distances greater than the size of the card, even when using much greater transmission power.

The primary benefit of space modulation is its very narrow radio spectrum: a reader which transmits data at great speed to the card is recognized by a receiver separated by more than a fourth of a meter as a non-modulated transmitter carrier, and therefore as a single frequency. A very beneficial resulting feature is the possibility of having several readers very close to one another operate without reciprocal interferences all using the same frequency.

Therefore, for very narrow bandwidth systems, radio-communication regulations are much more tolerant and several frequencies have already been attributed for remote control or telemetry applications.

In practice, to decrease the power implemented for this application, CMOS technology must be used for the electronic part of the card, permitting extremely reduced consumption. The diagram that will be described lends itself completely to this technology.

Other characteristics, goals and advantages of the invention will appear upon reading the detailed description below of a method of realization, done in reference to the attached figures, in which:

- figure 1 is a presentation of the most simple card-reader configuration,
- figure 2 is the graphic representation of different signals as a function of time during the transmission of the reader to the card,
- figure 3 is the graphic representation of different signals as a function of the time during the transmission of the card to the reader,
- figure 4 demonstrates a simplified principle diagram of the transmission-reception section of the reader.
- figure 5 demonstrates a simplified principle diagram of the transmission-reception section of the card.

Referring to these figures, chip card 1 of fig.1 includes in its volume, the electronic components of communication and calculation- memorization, in central zone 2, and two plane rectangular inductances 3 and 4 symmetrically placed at the edges of the card; the inductances are made using a flexible printed circuit technique.
The upper part of reader 5 includes an open cavity that can receive card 1; two inductances 6 and 7 similar to those of the card are placed under the base of the cavity made from a non-metallic material. When the card is placed in the reader, tight electromagnetic coupling is obtained between reel 3 of the card and reel 6 of the reader and, respectively, between reels 4 and 7; crossed couplings 3 to 7 and 4 to 6 are much weaker than the direct couplings.

The transfer of power supply for the card and bilateral transmission of all communication signals is accomplished by the two pairs of direct couplings:
- the continuous current supply voltage for the electronic card signals is obtained by rectifying the alternative signals permanently sent by the reader to the card;
- the clock signal for the synchronous functioning of the card is recovered from the alternative power permanently present in at least one of the two reels;
- the transmission of data from the reader to the card is transmitted by subdivision, varying over time, of the values of the signals applied to inductances 6 and 7; receiver reels 3 and 4 respectively translate into data the differences in amplitude between the signals received;
- the transmission data from the card to the reader are transmitted by sending signals modulated in frequency generated by the card circuits to inductances 3 and 4; the reader reception circuits demodulate the signals received by inductances 6 and 7.

To facilitate comprehension of the procedure for transmission of data from the reader to the card through "bounded space" modulation, reference must be made to figure 2:
- a series of logical signals "0" and "1" is presented comprising the data to be transmitted,

- on the second line, the voltage applied to the reel (6) of fig. 1 is presented: for the duration of the "1" logical signals, the signal is an alternative voltage of carrier frequency; during the "0" signals, the voltage is zero;
- on the third line the voltage applied to reel (7) of fig. 1 is presented and the situation is reversed; carrier signal for the "0" and lack of signal for the "1."

This extremely simple procedure has considerable advantages for applications. Firstly, it should be noted that the sum of two signals transmitted represents an alternative voltage without discontinuities, a pure carrier, and therefore:
- the corresponding coupled inductances of the card receive similar signals that will be detected; by summing the voltages detected a uniform continuous voltage is obtained which serves as power supply voltage;
- by subtracting the difference between the individual detected voltages, the data is obtained and the differential procedure grants a very high reliability for received data;
- if the passages through zero of the alternative voltages are demonstrated, simultaneously received by each card reel, a clock signal without discontinuities is obtained;
- the two transmitter reels excited by powerful radio-frequency signals, modulated in amplitude at great speed, represent individually wide-band, very disturbing radio interferences. However, a relatively distanced receiver will perceive the two transmitters as a single generator, since the two interferences are placed at a much lower distance relative to the wavelength transmitted. The two modulations can, therefore, be considered to reciprocally cancel one another out beginning at a certain distance and the resulting interference is a pure carrier.
In addition, the act of reading or modifying card data, exercised at a distance exceeding a dozen centimeters, becomes impossible because the necessary crossed fields cancel one another out; the card without contacts is thus offered additional security.

Reference must be made to the voltage diagrams in fig. 3 to facilitate comprehension of the procedure to transmit data from the card to the reader through digital modulation of frequency – FSK ("frequency shift"):
- the carrier signal F0 transmitted by the reader is given on the first line,
- the signal that will be used to transmit the logical "1" signals, which is obtained by dividing the F0 signal by three is given on the second line,
- the signal used to transmit the logical "0" signals , which is obtained by dividing the F0 signal by four is given on the third line,
- the data signal to be transmitted by the card is given on the fourth line,
- the resulting modulated signal received by the reader after filtering is given on the fifth line.

Such a choice of frequencies has the advantage that the much more powerful signal F0 and its harmonics do not disturb the FSK transmission, which uses frequencies located in the lower part of the spectrum; in addition, it will be seen that the structure of the marker circuits is greatly simplified.

In a probative realization a value of 132 kHz was chosen for the F0 frequency, which is one of the frequencies attributed for remote control transmission; SKF frequencies are 33 and 44 kHz and the data transmission speed is 11 kbit/s, greater than the speed of 9.6 kbit/s used for current contact cards.

In figure 4 there is a synopsis of the electronics of the communication of a reader. It consists of two identical inductances, square-loop antennas 6 and 7, which are connected respectively by capacitors 13 and 14 to two amplifiers 15 and 16, and by inductances 17 and 18, in the common point of capacitor 27 and the entry of the reception band pass filter. The entries of amplifiers 15 and 16 are connected by analog modulation switches 21 and 22 and by the analog switch of the transmission-reception method of operation 23, either throughout transmission (23B), alternatively at the exit of the filter of carrier 26 and at the ground, or both at the exit of filter 16, during reception (23A). At the entry of the filter of harmonics 26 the signals of the divider are applied by eight 25 which is controlled by the generator stabilized with quartz 24, comprising the time base of the system. It is also connected to receiver 29 of signals modulated in FSK frequency that receives the exit signal from filter 28 and which exits to microprocessor 30 of the data reader 30D sent by the card.

In transmission mode created by switch 23B, the data to be transmitted 30B control switches 21 and 22 so as to cut the F0 carrier signal frequency in accordance with fig. 2, executing direct modulation of amplitude on one channel and the opposite on the other. Capacitor 13 and reel 17, respectively capacitor 14 and reel 18 comprise high pass filtration cells and the RF exit signals of amplifiers 5 and 6 reach the corresponding antennas 6 and 7 without loss. Resistances 19 and 20 guarantee damping of the circuits through a relatively large pass band required for transmission of the modulated signals without distortion.

In reception mode, the two antennas are excited by permanent, identical carrier signals, providing the power supply and the clock for the chip card. The card sends the signal modulated in frequency in accordance with fig. 3; the FSK signals have a frequency three or four times lower than the carrier frequency. Reels 17 and 18 with capacitor 27 form pass band structures that promote the passage of summed signals received relative to carrier F0. The pass band filter 28 guarantees the rest of the filtering by eliminating carrier F0 and potential interference signals. The FSK receiver, which is traditional in structure, amplifies the FSK signals and limits them, transforming them in rectangular signals; demodulation is then effected by a delayed numerical demodulator, controlled by the 8xF0 frequency signal. Thus, the data sent by the card are available in a binary form at the 30D exit, to be handled by the reader microprocessor.

Figure 5 demonstrates the principal diagram of the communication section of the card. The antennae-inductances 31 and 32 are connected to capacitors 33 and 34 to form circuits tuned to the F0 frequency; the circuits thus formed are connected by diodes 36 and 37 at the positive common point of the filtration capacitor 35 and the stabilizing Zener diode 38. Thus the voltage of +5V in 70C is obtained powering the entire electronics of the card from the radio-frequency energy captured by one of the two antennas, by the other, or by both at the same time. The two antennas are connected together to the ground by resistance 39, of weak value; at the limits of this resistance the currents of the two tuned circuits develop permanent alternative voltage permitting recovery of the clock for the card; through capacitor 48 the signal is applied at the entry to the CMOS logical switch 49 which is used as an amplitude-limiting circuit amplifier, by applying a counter-reaction through resistance 50, of high value to have a high gain. Thus at the exit of circuit 49 a rectangular voltage with frequency F0 is obtained which is transmitted, through logical switch 51, to the transmission section and toward microprocessor 70, entry 70B.

It should be noted that the clock signal created by this layout is in quadrature relative to the useful voltages developed at the antenna boundaries: the rising edge of the clock at the exit of door 49 coincides with the negative peak values of the voltages developed at the boundaries of capacitors 33 and 34, and the descending front coincides with the positive peak value. This sign property is exploited during synchronous detection, as shall later be explained.

The clock signal is applied to counters 65 and 66 that divide by four and respectively by three and their exit signals comprise the F0/4 and F0/3 FSK signals for transmission of the card to the reader. A third counter 67, which divides by four, is mounted after counter 66 and a signal F0/12 is thus available that represents the data clock and is sent to the microprocessor at 70E to synchronize the data to be transmitted. The binary data provided by the microprocessor in 70F control analog switch 38 that presents the FSK signal at the exit.

In transmission mode, controlled by the microprocessor in 70D, the AND-NO gate 69 permits passage of the FSK signal. Diodes 44 and 45 connected to gate 60 have their anodes connected by resistances 40 and 41 to the antenna circuits; frequency signal F0 present at the boundaries of inductances 31 and 32 will undergo a small modulation in amplitude, with a signal of either F0/3 or F0/4. The antennas will therefore be traversed by variable current making up the FSK signal that will be received and handled by the reader by coupling.

In reception mode, the exit of gate 69 is in high level, therefore diodes 44 and 15 are blocked; the modulated signals sent by the reader arrive by inductances 31 and 32 and by resistances 40 and 41 to analog gates 46 and 47; diodes 42 and 43 represent short-circuits for negative signal alternations that may hamper gate operation. Interrupter switch 46 and capacitor 55 and respectively interrupter switch 47 and capacitor 56 comprise two synchronous detectors through sampling, one per channel, operating as follows:

- if the switch is closed for a very short period coinciding with the highest value of each positive alternation, the connected capacitor will charge rapidly through resistance 40 (or 41), of relatively weak value, up to peak voltage; then for the duration of the opening, the capacitor will keep this value, with a slight loss through the discharge in resistance 57 (or 58) or a much higher value than the load resistance. At the next alternation, the capacitor will memorize the new value and likewise; this configuration therefore permits reliable and trustworthy amplitude detection; reliability is guaranteed by the fact that synchronous detection is not affected by "non-follow-up" distortion, typical of amplitude detectors; reliability and therefore insensitivity to interference signals is high since the duration of sampling is brief compared to the total signal period. Another advantage, of a practical nature, is the reduced and non-critical value of the memorization capacity, and therefore the possibility of integrating the capacitors in a monolithic structure.
To create the sampling pulses the clock signal recovered at the exit of gate 49 is used; brief pulses must be used from descending front of the clock signal coinciding with the maximal positive values of the signals used.

Applying to one of the entries of the gate OR 54 the exit signal of gate 49 and to the other entry the switched signal through gate 51 slightly delayed by group RC 52/53, at the exit of gate 54 we obtain negative logical pulses of short duration, equal to the RC delay, which serve to control sampling gates 46 and 47.

Once the envelopes of the signals of the two radio channels are obtained which are complementary in accordance with the "bounded space" modulation, we proceed to differential demodulation of the logical data signals. Resistances 57, 58, 60 and 61 have the same value; logical switch 59 mounted in linear amplifier of unitary gain, through the resistance of counter-reaction 60 equal to 58 will provide a signal at the exit representing the switched copy of the voltage at the boundaries of capacitor 56; by applying this voltage at the entry of the switch amplifier 63 by resistance 61 and, at the same entry, the voltage of capacitor 55 by resistance 57, we obtain a voltage at the exit of amplifier 63 which represents the difference between the envelope voltages that are present on capacitors 56 and 55. Logical switch 64 functions as a comparator and at exit 70A we have:

- logical signal 1 if the signal captured by antenna 1 is bigger than the signal captured by antenna 2,
- logical signal 0 is the signal captured by antenna 1 is smaller than the signal captured by antenna 2.

Resistance to the interferences of this configuration consist of the fact that an interference signal generates on both channels similar signals that will be cancelled by the differential principle; one must have signals appropriate for modulation according to the invention to obtain the exit data.

In the communication protocol, with an adequate preamble, we can easily eliminate the ambiguous initial positioning of the card relative to the reader. The reader transmits a repetitive sequence 110110 in hold condition...; if the card receives a complementary sequence, 001001..., the card processor can decide before responding that all the data received must also be complemented.

The physical simplicity of making the electronic section housed on the card which, while performing quite complex processing, was designed to permit performance of all the active functions with a reduced number of simple CMOS structures for easy integration on a single monolithic structure. The only components that do not lend themselves to being made on silicone are printed antennas, tuning capacitors 33 and 34 and filtration capacitor 35; technologies currently available permit the integration of all the components in a card volume according to ISO standards. The tolerances of component values are large and no adjustments have to be made while the card is being manufactured.

It is important to note that the card may also use contacts to permit operation with current readers; to facilitate comprehension of the invention, this adaptation, which is obvious to those skilled in the art, has not been illustrated.

An additional compatibility with readers on a magnetic strip may also be imagined as long as, in accordance with the invention, an adequately high F0 frequency is used for communication, which does not affect the magnetic recording.

To make the reader, fig. 1 is the simplest construction, directly usable for store cashiers; for reader-distributors we can assume the ability to keep the cards with a simple mechanical part.

CLAIMS

1. Bilateral communication system without galvanic contacts between a reader (5) and a microprocessor card (1) and memory chip card without its own power supply, in particular a credit card, key cards, and computer media,
- the reader consists of:
- means (6, 7) for coupling with the card, to transmit and receive radio signals,
- means (24, 25, 26) for generating a signal from an initial frequency F0,
- means (21, 22) for modulating this F0 signal with the data to be transmitted,
- means (15, 16) for amplifying this F0 signal in power,
- means (23B, 23A) for changing the method of operation, for transmission or reception,
- means (17, 18, 27, 28) for filtering and amplifying the modulated response signal, issued by the card, to at least one frequency different from the F0 frequency,
- means (29) for demodulating this response signal, and
- a management microprocessor (30) for the entire system,

- the card consists of:
- means (3, 4) for coupling with the reader, to receive and transmit radio signals,
- means for rectifying (36, 37) filtering (35) and regulating (38) the signals received to obtain continuous power supply voltage for all the card circuits,
- means (39, 48 to 51) for creating the F0 frequency card signal, for the card circuits, from signals received,
- means (42,43,46,47,55,56) for detecting the modulated signals transmitted by the reader with the F0 frequency,
- means (57 to 64) for processing these signals detected, to form the entry data for the card microprocessor,
- means (65, 66, 67) for creating the signals with frequencies F0/3, F0/4 and F0/12, required for the transmission of the card to the reader,
- means (68, 69, 44, 45) for using these signals with the goal of generating the transmission signal modulated in frequency, and
- a microprocessor (70) for managing the communication and handling and memorizing data,

characterized in that said means (6, 13, 15 and 7, 14, 16) for sending transmission signals from the reader to the card and said means (3, 33, 4, 34) to receive said signals used to transport the power supply voltage by electromagnetic coupling to the card, the clock and data, are such that transmission takes place through two channels, two signals modulated in amplitude in a complementary manner, termed "bounded space modulation." This operation helps to allow a very narrow radiated radioelectric interference spectrum, independent of the speed of transmission, representing an important simplification of the card circuits and reliable and secure data transmission.

2. Communication system according to claim 1, characterized in that said methods of coupling the reader and said methods of coupling the card include pairs of plane inductances (6, 7) and respectively (3, 4) positioned symmetrically on their supports, forming, when this card is placed in the centering cavity of said reader two bilateral communication channels (3) with (6) and (4) with (7).

3. Communication system according to claims 1, and 2, characterized in that communication is effected in both directions using different modulations and carriers:
- from said reader to said card by this "bounded space" modulation,
- from said card to said reader by modulation of frequency applying to these inductances (3, 4) signals of lower frequency, obtained by division by three or four of the permanent F0 frequency signal sent by said reader, with the transfer occurring by these same couplings.

4. Communication system according to claim 1, characterized in that said means for generating the clock signal including the oscillator (24) and the divider (25) provide said signal F0 for transmission, and a signal of frequency 8xF0 for the microprocessor (30) and the numerical frequency demodulator (29).
5. Communication system according to claims 1 to 4, characterized in that, for the reader:
- said means of modulation include analog switches (21, 22), controlled by said microprocessor (30) in data rhythm, so as to alternatively apply said signal F0 either to the transmission channel formed by the amplifier (15), tuning capacitor on F0 (13) and said inductance (6), or to the channel formed by the corresponding elements (16, 14, 7).
- Said means of filtration and reception include the pass-band filter structures formed by said antenna-inductances (6 or 7) in series with the inductances (17 or 18) linked together with the capacitor (27), at the other boundary to the ground at the entry of the pass-band filter (27), all these elements cooperate with the goal of extracting the response signal from the card and eliminating said signal F0, present also at the boundaries of said inductances (6, 7), to provide said response signal modulated in frequency at the demodulator entry (29) delivering the data at the (30D) microprocessor entry.

6. Communication system according to claims 1, 2, and 3, characterized in that, on the card:
- said methods for rectifying, filtering and regulating the alternative signals coming from at least one of the tuned in circuits formed by this inductance (3) with the capacitor (33) and respectively (4) and (34), including the diodes (36) and (37) to rectify the filtration capacitor (35) and the Zener stabilizing diode (38).

- said means for creating the clock signal F0 for the card include the common resistance (39) for said tuned circuits (3, 33 and 4, 34), hence permanently traversed by the current of at least one of the circuits which delivers a voltage in quadrature relative to the ground in phase with the voltages at the boundaries of said tuned circuits, which, through the capacitor (48) is applied to the amplitude-limiting circuit amplifier with the CMOS switch (49) placed at a linear setting by the counter-reaction resistance of high value (50), and then by the switch (51) the clock signal is provided for the microprocessor (70B), for the formatter of sampling pulses (54) and the dividers (65, 66).

7. Communication system according to claims 1, 2, 3 and 6 characterized in that for detection of the two signals modulated in amplitude send by said reader, in complementary mode, sampling detectors are used – to advantage for immunity to interference, reliability and feasibility on a monolithic circuit- which include:
- said formatter of sampling pulses consisting of the logical circuit OR (54) (CMOS) which receives the clock signal at one of the entries and at the other the same signal switched by (51) and slightly delayed by the RC group (52, 53), thereby delivering brief pulses, which coincide with the maximal positive values of the voltages present in said tuned circuits, to control said analog switches (46,47).
- For the first channel, the load resistance (40) connected to the diode (42) to short-circuit to the ground the negative signal alternations received from said circuit (4, 33), the modulation diode (44), blocked during reception, and with the gate (46) of the capacitor (55) which is charged through resistance (40) during closing of said control switch (46) and which discharges in a negligible manner during opening through resistance (57), of a much greater value than said resistance (40), by recovering at the boundaries of said detection capacitor (55) the modulation envelope from the first channel signal,
- For the second channel, an identical structure consisting of the load resistance (41), the diodes (43,45), the gate (47), detection capacitor (56) and discharge resistance (58), recovering the radiofrequency signal modulation envelope present at the boundaries of said tuned circuit (4, 34).

8. Communication system according to claims 1, 2, 3, 6 and 7 characterized in that said means for treating said detected signals effect a differential data demodulation, thereby permitting high resistance to external interference, cancelled by this differential mode, with the assembly consisting of: - said discharge resistance (57, 58), of equal value,
- an amplifier switch of unitary gain obtained with the CMOS switch (59), linearized by the counter-reaction resistance (60) of the same value as the resistances (57, 58), and
- a summation stage obtained with the CMOS switch (63), linearized by the counter-reaction resistance (62), with the entry resistance (61) having the same value as the resistances (57, 58 and 60), thereby forming a group amplifying the difference in envelope between the two channels and the resulting signal is applied to the switch entry (64), used as a decision comparator, providing the reception data at the exit for said card microprocessor (70).

9. Communication system according to claims 1 to 6 characterized in that said means for generating the transmission signal from the card are created from said clock signal F0, by division by four carried out by the counter (65) and by three with the counter (66), with the frequency signals F0/4 and F0/3 being switched to data transmission by the analog switch (68) and the variable frequency signal (FSK) passing through the AND-NOT gate, if the transmission command is given by the microprocessor in (70D) and then by the diodes (44, 45) and resistances (40, 41), an amplitude modulation is obtained for the alternating signals with F0 frequency present at the boundaries of said tuned circuits (3, 33 and 4, 34) which will generate, through coupling with said reels (6, 7) of the reader, a signal modulated in frequency that will create reception for the reader through demodulation.

10. Communication system according to claim 9, characterized in that the card transmission data are generated at a rate corresponding to F0/12, using a clock signal from data with the same frequency sent in (70E) to the microprocessor, a signal which is obtained by additional division by four done by the counter (67), after division by three performed by said counter (66).

11. Communication system according to claims 1 to 10 characterized in that the ambiguity of positioning of the card in the cavity of the reader, before-behind, front-back, is automatically corrected by the preamble of the communication protocol, by having the reader transmit a repetitive data sequence of the type 110110... in hold condition, that will either be received normally by the card as 110110... and in this case the following data received will also be interpreted as correct by the card microprocessor or, if the preamble is received in the complementary form 001001..., the microprocessor shall decide, before responding, that the following received data must also be complemented before being interpreted.

12. Communication system according to claims 1 to 3 and 6 to 11, characterized in that the communication assembly without contacts made according to the invention may be rendered compatible with the current readers with contacts, by providing contacts on the card, and the card may be provided with magnetic strips for traditional readers, provided that in this case an adequately high value is used for said frequency F0, so as not to affect the magnetic recording.

13. A card reader for the communication system of claims 1 to 10.

14. A card for the communication system of claims 1 to 10.

15. A type of modulation, termed "bounded space modulation," for the communication system of claims 1 to 10.

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DOCUMENTS CONSIDERED PERTINENT

Category	Document citation with indication if needed, of pertinent sections	Claims concerned and the application examined
A	US-A-4 924 171 (BABA ET AL.) *abridged; claims 1-5; figures 1, 3 * *column 1, line 19 – column 3, line 10* *column 4, line 5 – line 50* ---	1-4
A	FRA-A-2 636 187 (YAMATAKE-HONEYWELL) *abridged; claim 1* ---	1,4
A	GB-A-2 164 825 (SATELLITE VIDEO SYSTEMS) *entire document* ---	1-5
A	EP-A-0 309 201 (HITACHI MAXELL) *entire document *	

TECHNICAL AREAS RESEARCHED (Int. Cl. 5)

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